Faculty of Natural and Applied Sciences Journal of Scientific Innovations
Print ISSN: 2814-0877 e-ISSN: 2814-0923
www.fnasjournals.com
Volume 5; Issue 3; March 2024; Page No. 87-94.

Risk Assessment of Pesticide Residues in Vegetables Cultivated in Selected Farmlands in Kaa Community, Ogoni, Rivers State, Niger-Delta

Momta, P.N., Marcus, A.C., & Uzamere, O.
Department of Chemistry, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education, P.M.B. 5047, Rumuolumeni Port Harcourt. Nigeria

***Corresponding author email:** momtaphilipnukeba@gmail.com

Abstract
Pesticide application is being employed in modern agricultural procedures for growing crops. Their usage has the potential to have catastrophic consequences for both the environment and human health. The study was thus carried out to examine the amounts of pesticide residues in vegetables - fluted pumpkin and waterleaf (*Telfairia occidentalis L.* and *Talinum triangular)* samples. Vegetables - fluted pumpkin and waterleaf samples from six farmlands in Kaa, an Ogoni community in Rivers States, Nigeria were collected. Vegetables-fluted pumpkin and waterleaf samples were extracted and analyzed using GC-MS for the presence of pesticide residues. Risk assessment was carried out using different risk index models. The results of the analysis showed that out of 16 pesticides tested, 11 were detected in fluted pumpkin and waterleaf samples in the range of non-detectable (ND) to 10.65 mg/kg and 11.25 mg/kg respectively. The highest concentrations, 10.65 mg/kg and 11.25 mg/kg were notably observed for Pendimethalin while several pesticides, including Methomyl, Acetamiprid, α-Lindane, Cypermethrin, and λ-Cyhalothrin, were not detected in the samples in any of the various sampling locations. The residue level of pendimethalin in fluted pumpkin and waterleaf was found to be above the limit of quantification (0.05 mg/kg). However, the levels and application of pesticides especially Pendimethalin should be monitored and minimized since it is frequently used to control weeds in order not to interfere with the food chain.

Keywords: Pesticide residues; hazard index; health risk; *Telfairia occidentalis; Talinum triangulere;*Kaa.

Introduction

Vegetables are a crucial part of our diet as they contain essential nutrients that our bodies need. They not only help prevent vitamin deficiencies but also decrease the risk of severe diseases like cancer, heart disease and obesity. Due to urbanization and population growth, people's lifestyles and eating habits have changed, and food preferences have diversified. This has impacted food production and consumption, and farmers have implemented stricter plant protection measures to combat pests and weeds. Pesticides are widely used in pest management due to their quick action, easy application, and low cost. These persistent organic pollutants (POPs) have become a vital part of the farming system, being used for crop protection against insects, fungi, weeds, rodents, and animal health. However, misuse or accidental application of pesticides can harm plants, animals, the environment, and human health. Pesticides often leave residues in the environment, following application, spillage, or disposal. Vegetables, which provide a consistent source of vitamins, minerals, and fibre, are often contaminated with excessive pesticide levels, especially in developing countries. As most consumers are unaware of these residues in food, this can pose a significant health risk to millions of people who consume them.

There are serious concerns related to the harmful effects of pesticides, which can cause various health issues such as cancer, asthma, fetal development disruption, and reproductive system disorders (Gilden et al., 2010). Some pesticides are persistent and can cause long-term exposure-related issues like infertility, neurotoxicity, cytogenetic damage, endocrine system disorders, leukemia, non-Hodgkin lymphoma, and several types of cancer including brain, bone, breast, ovarian, prostate, testicular, and liver cancer. Even short-term exposure to pesticides can lead to health problems like headaches and nausea (Ayejuyo et al., 2008). Chemical pesticides, especially organochlorine pesticides (OCPs), are known for their lipophilic nature and stable structure. Due to this nature, they tend to bioconcentrate and bioamplify in food chains, especially those linked to fatty tissues. This can lead to toxicity in non-target organisms, including humans, vertebrates and non-vertebrates, as reported by Okoya et al. (2013) and

Masia et al. (2013). These pesticides contain heavy metals like Zn, Cd, Pb, Cu, and Cr, as reported by Yuguda et al. (2015). Therefore, a study was conducted to evaluate the levels of pesticide residues in vegetables - fluted pumpkin and waterleaf (*Telfairia occidentalis L*. and *Talinum triangulere*) - from selected farmlands in Kaa, an Ogoni community in Rivers State, Niger Delta. The study also aimed to assess the risk posed by these residues.

Materials and Methods

The study was carried out on six (6) agricultural farmlands of Wiikedu Kaa (K1), Wiipina (K2), Wiideekekuekaa (K3), Wiikorro (K4) and Wiikuekaa (K5) located in Kaa, a community in Ogoni, Khana Local Government Area of Rivers State in the Niger-Delta. A farmland at Wiigbor (KC) where pesticides are not applied was used as control. The Kaa people like every other Ogoni community, are competent farmers and fishermen that produce food (crops and fish) in commercial quantity. They are described as the food basket of the Eastern Niger Delta due to food production and other commercial activities that take place in the area. Thus, the farmlands used for the study are purely for agricultural activities. Apart from farming and fishing activities in the study area, other anthropogenic activities such as construction and transportation (including illegal oil bunkering) take place.

Table 1: Coordinates of Sampling Areas

	Locations					
	K1	**K2**	**K3**	**K4**	**K5**	**KC**
Latitude	4˚34′15.9″N	4˚34′43.8″N	4˚35′0.66″N	4˚34′46.8″N	4˚35′17.8″N	4˚34′41.9″N
Longitude	7˚22′8.11″E	7˚21′48.2″E	7˚22′48.4″E	7˚21′58.8″E	7˚22′11.7″E	7˚21′55.9″E

Sample collection: Leaf of vegetables-fluted pumpkin (*T.occidentalis*) and waterleaf (*T. triangulare*) were obtained from selected farmlands in Kaa community, Khana Local Government Area, Ogoni, Rivers State. Samples from each sampling location were collected in a well-labelled polythene bag and were transported to the Chemistry laboratory of Ignatius Ajuru University of Education, Port Harcourt for analysis Vegetable samples where no pesticides were used were also collected for comparative analysis.

Sample preparation, extraction and cleanup: To extract pesticides from a vegetable sample, 2g of air-dried and finely ground sample were mixed with 40 ml of ethyl acetate, 40 ml of dichloromethane (DCM), 150 ml of distilled water, and 5 grams of NaCl using a magnetic stirrer. The resulting mixture was then placed in a separating funnel and left undisturbed for half an hour until two layers had formed. The organic layer at the bottom was collected in a beaker. An additional 40 ml of ethyl acetate: DCM (1:1) was added to the top layer. When the bottom organic layer had formed, it was collected and combined with the upper layer. This process was repeated twice for every vegetable sample. The extract obtained was kept in a plastic bottle for pesticide analysis. A standard of high-purity pesticides (α-Lindane, butachlor, aldrin, cypermethrin, dieldrin, pendimethalin, endosulfan, and propanil) was prepared at concentrations ranging from 0.10 to 2.00 ppm. Anthracene was incorporated as an internal standard.

Sample Analysis for Pesticides: The samples were analyzed using Gas Chromatography-Mass Spectroscopy (GC-MS). Firstly, 15 ml of methanol was added to both the prepared samples and standard vials, filling them to the brim. The GC-MS vials were then rinsed with distilled water and methanol before being loaded with the prepared samples and standards. The solution produced after extraction and cleaning was diluted by adding 5 to 7 ml of methanol to 0.5 ml of sample, depending on the consistency of the sample and the desired hue. For dark-coloured samples, 7 ml of methanol was added, while for light-coloured ones, 5 ml of methanol was used. Next, each dilution was injected into the GC-MS system equipped with a Diode UV/V detector set at 254 nm. The C18 Licospher column was used, with a mobile phase of acetonitrile: water (40:60) at a flow rate of 1.0 ml/min and a column temperature of 25°C. The injection volume was 5.000 µl, and helium was employed as the carrier gas. Finally, the response factor, the peak area of standard, standard quantity, and analyte concentration in each sample were recorded and computed based on the analyte amount.

Statistical Analysis: The data was analyzed for distribution among examined factors in vegetables using fundamental statistical indicators like average and standard deviation. Pesticide residue data were analyzed using statistical software version 16.0. Index models for risk assessment: Human health risk assessment involves determining the likelihood and type of adverse health consequences in individuals exposed to substances in contaminated environmental media. The potential non-carcinogenic and carcinogenic health risks can be quantified using the target hazard quotient (HQ) and the hazard index (HI), respectively. A HI value exceeding 1 indicates the presence of potential non-carcinogenic risk, whereas a total potential carcinogenic health risk (TCR) greater than 1×10^{-4} suggests a high risk to human health. Conversely, a TCR value less than 1×10^{-6} implies negligible carcinogenic health risk caused by pesticide residues.

To assess the magnitude of pesticide residues, a health risk assessment was conducted. Health risk assessment of pesticide residues: The level of risk linked with pesticide ingestion was assessed by analyzing the findings of pesticide residues discovered in samples. The health risk index was calculated by combining Estimated Daily Intake (EDI) and Accepted Daily Intake. The ADI was derived from literature studies. The EDI was derived by multiplying the typical person's daily consumption (kg/day) by the residual pesticide concentration (mg/kg) and dividing by the average adult weight (60 kg). The European Food Safety Authority (EFSA, 2012) used the method below to compute the health risk index for each pesticide:

$$\text{Health Risk Index} = \frac{\text{estimated daily intake (EDI)}}{\text{acceptable daily intake (ADI)}}$$

EDI= concentration of detectable pesticides (mg/kg) × Food consumption (kg/day)/body weight of 60 kg for an adult.

Results

Table 2 Levels (mg/kg) of pesticide residues in fluted pumpkin (FP) from the various sampling locations

Location	K1 FP	K2 FP	K3 FP	K4 FP	K5 FP	Kc FP
Methomyl	ND	ND	ND	ND	ND	ND
Carbofuran	0.083±0.012	0.337±0.045	0.367±0.045	0.183±0.012	0.123±0.042	0.037±0.006
Acetamiprid	ND	ND	ND	ND	ND	ND
Profenofos	0.157±0.015	0.497±0.035	0.130±0.030	0.757±0.015	0.190±0.020	0.100±0.010
Parathion	0.200±0.017	0.410±0.050	0.417±0.040	0.740±0.070	0.247±0.025	0.127±0.031
α-Lindane	ND	ND	ND	ND	ND	ND
Pendimethalin	3.387±0.122	3.893±0.114	3.903±0.111	10.65±0.308	4.220±1.040	3.407±0.358
Propanil	0.453±0.067	0.773±0.040	0.773±0.040	0.830±0.030	0.573±0.368	0.397±0.0153
Chlorpyrifos	0.197±0.0152	0.360±0.046	0.400±0.010	0.387±0.035	0.645±0.047	0.117±0.048
Butachlor	0.513±0.040	0.310±0.017	0.513±0.029	0.460±0.056	0.563±0.035	0.353±0.025
Heptachlor	0.337±0.023	0.287±0.025	0.297±0.012	0.587±0.071	0.380±0.017	0.217±0.021
Endosulfan	0.107±0.015	0.087±0.006	0.073±0.015	0.173±0.029	0.097±0.012	0.067±0.015
Aldrin	0.063±0.015	0.073±0.015	0.073±0.015	0.120±0.030	0.073±0.015	0.047±0.006
Cypermethrin	ND	ND	ND	ND	ND	ND
Dieldrin	0.057±0.006	0.070±0.017	0.073±0.006	0.083±0.015	0.077±0.015	0.030±0.010
λ-Cyhalothrin	ND	ND	ND	ND	ND	ND

ND=Not Detected; KC=Control location; FP=Fluted pumpkin leaf; n=3.

Table 3 Levels (mg/kg) of pesticide residues in water leaf (WL) from the various sampling locations

Location	K1 WL	K2 WL	K3 WL	K4 WL	K5 WL	Kc WL
Methomyl	ND	ND	ND	ND	ND	ND
Carbofuran	0.077±0.015	0.373±0.152	0.580±0.061	0.207±0.021	0.090±0.017	0.030±0.010
Acetamiprid	ND	ND	ND	ND	ND	ND
Profenofos	0.097±0.012	0.510±0.020	0.190±0.017	0.717±0.055	0.193±0.031	0.073±0.012
Parathion	0.167±0.015	0.393±0.029	0.620±0.030	0.720±0.046	0.323±0.031	0.097±0.025
α-Lindane	ND	ND	ND	ND	ND	ND
Pendimethalin	1.280±0.026	4.123±0.46	5.747±1.117	11.25±1.083	4.727±0.021	1.073±0.025
Propanil	0.400±0.026	0.833±0.045	0.833±0.012	0.913±0.068	0.870±0.111	0.360±0.026
Chlorpyrifos	0.120±0.013	0.350±0.053	0.493±0.040	0.377±0.012	0.617±0.035	0.120±0.017
Butachlor	0.313±0.040	0.330±0.017	0.620±0.030	0.523±0.023	0.687±0.031	0.270±0.030
Heptachlor	0.200±0.00	0.283±0.023	0.430±0.056	0.627±0.025	0.420±0.030	0.177±0.021
Endosulfan	0.083±0.012	0.077±0.012	0.130±0.017	0.270±0.017	0.087±0.015	0.050±0.010
Aldrin	0.063±0.025	0.083±0.012	0.080±0.017	0.093±0.021	0.077±0.023	0.033±0.006
Cypermethrin	ND	ND	ND	ND	ND	ND
Dieldrin	0.067±0.015	0.080±0.010	0.090±0.010	0.117±0.021	0.087±0.015	0.027±0.006
λ-Cyhalothrin	ND	ND	ND	ND	ND	ND

ND=Not Detected; KC=Control location; WL=Water leaf; n=3.

Table 4 HQ hazard quotient and EADI estimated average daily intake of pesticide residues in vegetables for the adult category.

	Fluted Pumpkin (FP)			Water Leaf (WL)		
Pesticides	**EADI**	**HQ**	**HI**	**EDI**	**HQ**	**HI**
Acetamiprid	ND	ND	25.74	ND	ND	28.65
Aldrin	2.15E-04	2.15E+00		2.12E-04	2.12E+00	
Butachlor	1.26E-03	1.26E-02		1.32E-03	1.32E-02	
Carbofuran	5.84E-04	1.95E-01		7.09E-04	2.36E-01	
Chlorpyrifos	1.06E-03	1.06E+00		1.05E-03	1.05E+00	
Cypermethrin	ND	ND		ND	ND	
Dieldrin	1.92E-04	1.92E+00		2.36E-04	2.36E+00	
Endosulfan	2.87E-04	4.78E-02		3.46E-04	5.76E-02	
Heptachlor	1.01E-03	2.02E+00		1.05E-03	2.09E+00	
Methomyl	ND	ND		ND	ND	
Parathion	1.08E-03	1.08E-02		1.19E-03	1.19E-02	
Pendimethalin	1.39E-02	1.39E-01		1.45E-02	1.45E-01	
Profenofos	9.25E-04	4.62E-03		9.12E-04	4.56E-03	
Propanil	1.82E-03	1.82E+01		2.06E-03	2.06E+01	
α-Lindane	ND	ND		ND	ND	
λ-Cyhalothrin	ND	ND		ND	ND	

Cite this article as:
Momta, P.N., Marcus, A.C., & Uzamere, O. (2024). Risk assessment of pesticide residues in vegetables cultivated in selected farmlands in Kaa Community, Ogoni, Rivers State, Niger Delta. *FNAS Journal of Scientific Innovations, 5*(3), 87-94.

Table 5 HQ hazard quotient and EADI estimated average daily intake of pesticide residues in vegetables for children category.

	Fluted Pumpkin (FP)			Water Leaf (WL)		
Pesticides	**EADI**	**HQ**	**HI**	**EDI**	**HQ**	**HI**
Acetamiprid	ND	ND	83.50	ND	ND	92.93
Aldrin	6.97E-04	6.97E+00		6.86E-04	6.86E+00	
Butachlor	4.09E-03	4.09E-02		4.29E-03	4.29E-02	
Carbofuran	1.89E-03	6.32E-01		2.30E-03	7.67E-01	
Chlorpyrifos	3.45E-03	3.45E+00		3.39E-03	3.39E+00	
Cypermethrin	ND	ND		ND	ND	
Dieldrin	6.24E-04	6.24E+00		7.64E-04	7.64E+00	
Endosulfan	9.31E-04	1.55E-01		1.12E-03	1.87E-01	
Heptachlor	3.27E-03	6.55E+00		3.40E-03	6.79E+00	
Methomyl	ND	N D		ND	ND	
Parathion	3.49E-03	3.49E-02		3.85E-03	3.85E-02	
Pendimethalin	4.52E-02	4.52E-01		4.70E-02	4.70E-01	
Profenofos	3.00E-03	1.50E-02		2.96E-03	1.48E-02	
Propanil	5.90E-03	5.90E+01		6.67E-03	6.67E+01	
α-Lindane	ND	ND		ND	ND	
λ-Cyhalothrin	ND	ND		ND	ND	

Discussion

The presence of pesticides in our fruits and vegetables is a growing concern, and the results of our recent study show that this concern is not unfounded. Our research revealed that the vegetable samples we collected, specifically fluted pumpkin and waterleaf, contained varying amounts of 16 different pesticides. These concentrations ranged from non-detectable to as high as 11.25 mg/kg, with the highest levels of 10.65 mg/kg and 11.25 mg/kg being observed for the pesticide Pendimethalin in location K4. The pesticide residues in the fluted pumpkin and waterleaf samples detected were in the range: Carbofuran (0.037 - 0.367 mg/kg and0.077 - 0.580 mg/kg), Profenofos (0.100 - 0.497 mg/kg and 0.073 - 0.717 mg/kg), Parathion (0.127 - 0.740 mg/kg and 0.097 - 0.720 mg/kg), Pendimethalin (3.387 - 10.65 mg/kg and 1.073 - 11.25 mg/kg), Propanil (0.397 - 0.830 mg/kg and 0.360 - 0.913 mg/kg), Chlorpyrifos (0.117 - 0.646 mg/kg and 0.120 - 0.617 mg/kg), Butachlor(0.310 - 0.563 mg/kg and 0.270 - 0.687 mg/kg), Heptachlor (0.217 - 0.587 mg/kg and 0.177 - 0.627 mg/kg), Endosulfan (0.067 - 0.173 mg/kg and 0.050 - 0.270 mg/kg), Aldrin (0.047 - 0.120 mg/kg and 0.033 - 0.093 mg/kg) and Dieldrin (0.030 - 0.083 mg/kg and 0.027 - 0.117 mg/kg). However, it is important to note that Methomyl, α-Lindane, Cypermethrin, Acetamiprid, and λ-Cyhalothrin were not detected in any of the various sampling locations.

Out of the eleven samples that were tested, 68.75% of them contained detectable amounts of pesticide residues. The percentage contribution revealed that pendimethalin had the highest mean percentage contribution in fluted pumpkin and waterleaf, with 50.66% and 19.44%, respectively, while aldrin had the lowest contribution, with 2.31% and 1.84%, respectively. The prominent pesticides found were pendimethalin, butachlor, propanil, profenofos, and parathion. This high pesticide contamination may be due to vegetable farmers' recent use of persistent insecticides to produce vegetables, possibly because of its low cost and effectiveness in controlling various pests (Yang et al., 2005). Nonpoint sources such as transportation from agricultural farmland or soil into vegetable plantations may also be the cause of high pesticide contamination. The residual level of pendimethalin in fluted pumpkin and waterleaf was higher than the value of 0.05 mg/kg reported by Adeleye et al. (2019). Pendimethalin is known for its residual activity providing long-lasting weed control, which can be an advantage in reducing the need for multiple herbicide applications during a single growing season. However, its long-lasting nature can also raise environmental concerns. Therefore, it is important to use this herbicide according to recommended application rates and timings to minimize the risk of residues in soil and water. Proper application techniques and adherence to safety guidelines are crucial.

The mean level of endrin and endrin aldehyde detected in kolanuts from Osun State, Nigeria was 0.045-0.059 mg/kg and 0.208-0.201 mg/kg, respectively (Sosan & Oyekunle, 2017), whereas endrin detected in cabbage, carrot, and okra taken from local markets in Kumasi, Ghana was 0.016 mg/kg for all vegetables (Bempah et al., 2011a). Kolani et al. (2016) revealed that endrin levels in lettuce and cabbage from Togo's agricultural areas were 0.039-0.038 mg/kg and 0.055-0.008 mg/kg, respectively. The reported amounts of endrin and endrin aldehyde were consistent with those found in fluted pumpkin and water leaf in this investigation. Aldrin is used to manage soil-dwelling insects such as cocoa mirids, termites, locusts, ants, and other pests. Dieldrin and aldrin are outlawed in Nigeria, yet some are still used there (FMEHUD, 2009). Akan et al. (2014) found that dieldrin and aldrin were more prevalent on cabbage leaf samples from Alau Dam and Gongulong Agricultural areas in Borno State, North-eastern Nigeria, with mean concentrations of 10.4 mg/kg and 59.9 mg/kg, respectively, which were significantly greater than the levels found in this study. Furthermore, Benson and Aruwajoye (2011) observed dieldrin on *Solanum lycopersicum* (0.024-0.023 mg/kg) and *Capsicum annum* (0.019-0.003 mg/kg) obtained from local markets in Ota, South-western Nigeria, and Jallow et al. (2017) reported only one organochlorine insecticide (aldrin) in all fruits and vegetables samples from Kuwait, with a concentration of aldrin and dieldrin that were within the values recorded in this study. The levels of aldrin and dieldrin detected in fluted and waterleaf in this investigation were significantly higher than the EU's maximum residue limits (MRLs) of 0.01 mg/kg (Adeleye et al., 2019). Akan et al. (2014) also found pesticide residues in spinach, lettuce, cabbage, tomatoes, and onions that exceeded the MRLs. In contrast, Ibitomi and Mohammed (2016) found that the amounts of all pesticides observed in fruit and vegetable samples from Kaduna Metropolis markets were lower than the EU MRL.

Tables 4 and 5 show the Hazard Quotient (HQ), Estimated Average Daily Intake (EADI) or Average Daily Dose and Acceptable Daily Intake (ADI) of pesticide residues in fluted pumpkin and waterleaf for adult and children categories, respectively. In fluted pumpkin (for the adult category), Acetamiprid, Cypermethrin, λ-Cyhalothrin and α-Lindane were consistently not detected (ND), indicating their absence. EADI values of the pesticide residues in fluted pumpkin ranged from 1.39×10^{-2} to 9.25×10^{-4} with the lowest found in Pendimethalin and the highest in Profenofos while HQ of the pesticide residues ranged from 1.06 in Chlorpyrifos to 4.62×10^{-2} in Profenofos. EADI values of the pesticide residues in waterleaf ranged from 1.45×10^{-2} to 9.12×10^{-4} with the lowest found in Pendimethalin and the highest in Profenofos. HQ of the pesticides ranges from 1.05 in Chlorpyrifos to 4.56×10^{-3}in Profenofos. All of the HQ values for the pesticide residues in fluted pumpkin and waterleaf for both children and adult categories data are <1, indicating that the estimated pesticide exposure for children is within acceptable limits and that daily intake of these does not pose health risk hence considered safe for human consumption. Pesticide residues were estimated in green-house cucumber, cantaloupe, and melon samples from markets in Iran by the QuEChERS extraction method based on analysis with UHPLC-MS/MS (Mahdavi et al., 2022). The study compared non-carcinogenic and carcinogenic probabilistic health risk assessments using HQ, HI, and CR. The study found that adult and kid consumers had HQ values <1 for all pesticide residues. In the current study, the cumulative hazard index (CHI) for non-carcinogenic health effects in the fluted pumpkin and waterleaf indicated that children (83.50 and 92.93) and adults (25.74 and 28.65) had CHI values >1, implying that both adults and children could be at risk of consuming the vegetable from the study area. The results obtained are higher than the findings of Adeleye et al. (2019) who revealed that CHI in grown leafy vegetables from South Western Nigeria for children was 68.916 and adults 19.182.

The assessments of health risks in both the children and adult categories, as determined from the analysis of vegetable samples, exhibit similarity with the health risk estimations of Organochlorine Pesticides (OCPs) in kolanuts derived from the markets in Osun State, Nigeria. These previous findings revealed that the HI values for pesticide residues, including endosulfan sulfate, α-endosulfan, and β-endosulfan, remained below the threshold of 1 (Sosan & Oyekunle, 2017).In a separate study conducted by Adefemi et al. (2018), it was documented that heptachlor, aldrin, heptachlor epoxide, and endrin aldehyde detected in *Senecio biafrae* from Ekiti State, Nigeria, posed non-carcinogenic health risks for children. Furthermore, the studies of Bempah et al. (2011b) and Donkor et al. (2015) indicated that the presence of endrin aldehyde, heptachlor, and heptachlor epoxide in tomatoes from Ghana posed health hazards to children. Moreover, a related study by Bempah et al. (2011a) reported the presence of endrin in vegetables from another study area in Ghana, which also implied a potential risk to children consumers of contaminated vegetables. These outcomes align with the findings obtained in the present study. The EDIs of fluted pumpkin for adult and children categories ranged between 1.01×10^{-3} - 9.25×10^{-4} and 4.52×10^{-2}-6.97×10^{-4}mg/kg body weight/day, respectively. For waterleaf, it ranged between 1.45×10^{2}-7.09×10^{-4} mg/kg body weight/day. The lifetime consumption of these vegetables may not pose a health risk as the indices for all the residues were<1 (Darko & Akoto, 2008).

EADI values of the pesticide residues in fluted pumpkin ranged from 4.52×10^{-2} - 9.31×10^{-4} with the lowest found in Pendimethalin and the highest in Endosulfan. HQ of the pesticide residues in fluted pumpkins ranged from 3.45 in Chlorpyrifos to 4.09×10^{-2} in Butachlor. EADI values of the pesticide residues in waterleaf ranged from 4.70×10^{-2} to 7.64×10^{-4} with the lowest found in Pendimethalin and the highest in Dieldrin. Notably, in fluted pumpkin and waterleaf (for children and adult categories), Acetamiprid, Cypermethrin, Methomyl, λ-Cyhalothrin and α-Lindane residues were consistently not detected (ND), indicating their absence.

Conclusion

In this study, the residue levels and potential health risk of pesticides in two vegetables – fluted pumpkin and waterleaf (*T. occidentalis L*. and *T. triangulere)* cultivated in selected farmlands in Kaa, an Ogoni community in the Niger Delta were assessed. In the analyzed samples, five (Methomyl, acetamiprid, α-Lindane, cypermethrin and λ-Cyhalothrin) out of 16 tested pesticides were not detected in the vegetable samples. Eleven samples (68.75%) contained detectable amounts of pesticide residues. The percentage contribution showed that pendimethalin had the highest mean percentage contribution in fluted pumpkin and waterleaf (50.66% and 19.44%) while aldrin had the lowest mean percentage contribution of (2.31% and 1.84%). The results of non-carcinogenic and carcinogenic probabilistic health risk indicated HQ values were <1 in adult and children consumers for all pesticide residues indicating that the estimated pesticide exposure for children is within ADI. Hence poses no health risk. However, the CHI for non-carcinogenic health effects in the fluted pumpkin and waterleaf indicated that children (83.50 and 92.93) and adults (25.74 and 28.65) had CHI values >1 suggesting that both the adults and children could be at risk for consuming the vegetable from the study area on long term. From the findings of this study, the risk associated with consuming vegetables planted within the study environment is safe. However, the levels and application of pesticides especially pendimethalin should be monitored and minimized since it is frequently used to control weeds in order not to interfere in the food chain. Therefore, it is crucial to adopt sustainable and environmentally friendly farming practices to reduce our dependence on chemical pesticides and ensure the safety of our food and environment.

References

Adefemi, S.O., Asaolu, S.S., Ibigbami, O.A., Orege, J.I., Azeez, M.A., & Akinsola, A.F. (2018). Multi-residue levels of persistent organochlorine pesticides in edible vegetables: a human health risk assessment. *Journal of Agricultural and Food Chemistry, 7*, 143–152.

Adeleye, O.A., Sosan, M.B., & Oyekunle, J.A.O. (2019). Dietary exposure assessment of organochlorine pesticides in two commonly grown leafy vegetables in South-western Nigeria. *Heliyon, 5*(6), 1-8.

Akan, J.C., Jafiya, L., Chellube, Z.M., Mohammed, Z., & Abdulrahman, F.I. (2014). Determination of some organochlorine pesticide residues in vegetable and soil samples from Alau dam and Gongulong agricultural sites, Borno State, North Eastern Nigeria. *International Journal of Environmental & Ecological Engineering, 8*(4), 325–332.

Ayejuyo, O.O., Williams, A.B.,& Igbasan, S.O. (2008). Assessment of organochlorine pesticide residues in irrigation groundwater of Lagos. *Journal of Chemical Society of Nigeria, 3*,65-69.

Bempah, C.K., Buah-Kwofie, A., Denutsui, D., Asomaning, J., & Tutu, A.O. (2011a). Monitoring pesticide residues in fruit and vegetables and related health risk assessment in Kumasi metropolis, Ghana. *Research Journal of Environment and Earth Science, 3*(6), 761-771.

Bempah, C.K., Donkor, A., Yeboah, P.O., Dubey, Brajesh., & Osei-Fosu, P. (2011b). A preliminary assessment of consumer's exposure to organochlorine pesticides in fruits and vegetables and the potential health risk in Accra Metropolis, Ghana. *Food Chemistry, 128*(4), 1058–1065.

Benson, N.U., & Aruwajoye, O.I. (2011). Assessment of contamination by organochlorine pesticides in *Solanum lycopersicum L*. and *Capsicum annuum L*: a market survey in Nigeria. *African Journal of Environmental Science and Technology, 5*(6), 437–442.

Darko, G., & Akoto, O. (2008). Dietary intake of organophosphorus pesticide residues through vegetables from Kumasi, Ghana. *Food and Chemical Toxicology*, *46*, 3703–3706.

Donkor, A., Bempah, K.C., Dubey, B.K., & Attandoh, N. (2015). Chlorinated pesticide residues in selected fruits from some Ghanaian markets and the possible impact on children's health. *Research Journal of Chemistry and Environmental Science*, *3*(1), 10-18.

European Food Safety Authority (EFSA) (2012). Cumulative risk assessment of pesticides to human health: The way forward.

Federal Ministry of Environment (FMEHUD) (2009). Federal Republic of Nigeria national implementation plan for the Stockholm convention on Persistent Organic Pollutants (POPS) final report. Available at http://chm.pops.int/Portals/0/download.aspx?d¼UNEP-POPS-NIP-Nigeria-1.English.pdf, 131.

Gilden, R.C., Huffling, K., & Sattler, B. (2010). Pesticides and health risks. *Journal of Obstetric*, *Gynecologic and Neonatal Nursing*, *39*(1), 103- 110.

Ibitomi, M.O., & Mohammed, F. (2016). Determination of pesticide residues in fruits and vegetables in Kaduna Metropolis, Nigeria. *International Journal of Environmental Science and Toxicology Research*, *4*(10), 185–189.

Jallow, M.F.A., Awadh, D.G., Albaho, M.S., Devi, V.Y., & Ahmad, N. (2017). Monitoring of pesticide residues in commonly used fruits and vegetables in Kuwait. *International Journal of Environmental Research and Public Health*, *14,* 1–12.

Kolani, L., Mawussi, G., & Sanda, K. (2016). Assessment of organochlorine pesticide residues in vegetable samples from some agricultural areas in Togo. *American Journal of Analytical Chemistry*, *7*, 332–341.

Mahdavi, V., Eslami, Z., Molaee-Aghaee, E., Peivasteh-Roudsari, L., Sadighara, P., Thai V.N., Fakhri Y., & Ravanlou, A.A. (2022). Evaluation of pesticide residues and risk assessment in apples and grapes from the western Azerbaijan Province of Iran. *Environmental Research*, *203*: https://doi.org/10.1016/j.envres.2021.111882.

Masia, A., Ibanez, M., Blasco, C., Sancho, J. V., Pico, Y., & Hernandez, F. (2013).Combined use of liquid chromatography triple quadrupole mass spectrometry and liquid chromatography quadrupole time-of-flight mass spectrometry in systematic screening of pesticides and other contaminants in water samples. *Analytica Chimica Acta*, *761*, 117-127.

Okoya, A. A., Ogunfowokan, A. O., Asubiojo, O. I.,& Torto, N. (2013). Organochlorine pesticide residues in sediments and waters from cocoa-producing areas of Ondo State, Southwestern Nigeria. *InternationalScholarlyResearchNotices*(ISRN) *SoilScience*, *2013*, 1-12.

Sosan, M.B., & Oyekunle, J.A.O. (2017). Organochlorine pesticide residue levels and potential human risks in kola nut from selected markets in Osun State, South Western Nigeria. *Asian Journal of Chemistry and Science, 2*(4), 1–11.

Yang, R.Q., Lv, A.H., Shi, J.B., & Jiang, G.B. (2005). The levels and distribution of organochlorine pesticides (OCPs) in sediments from the Haihe River, China. *Chemosphere*, *61*, 347–354.

Yuguda, A. U., Abubakar, Z. A., Jibo, A.U., AbdulHameed, A., & Nayaya, A. J. (2015). Assessment of toxicity some of agricultural pesticides on earthworms (*Lumbricus terrestris). American-Eurasian Journal of Sustainable Agriculture, 9*(4), 49 – 59.

Cite this article as:
Momta, P.N., Marcus, A.C., & Uzamere, O. (2024). Risk assessment of pesticide residues in vegetables cultivated in selected farmlands in Kaa Community, Ogoni, Rivers State, Niger Delta. *FNAS Journal of Scientific Innovations, 5*(3), 87-94.